Iot-Based Leaf Disease Identification And Detection Using Successive Method For Feature Extraction

Raju Kolluri[1], Venkata Lakshmaiah Y[2], A. Rajesh[3] &D. Yugandhar[4]

[1,2] Department of Electronics and Communication Engineering, Narasaraopeta Engineering College, Narasaraopet, Andhra Pradesh, India.

[3,4]Department of ECE, Aditya Institute of Technology and Management, Tekkali, Andhra Pradesh, India.

Abstract

Developing a prototype system to identify paddy diseases, such as bacterial leaf spot, sectorial leaf spot, target spot, and leaf mold disease, is the primary goal of this project. This research focuses on the use of neural networks to classify paddy disease and image processing techniques to improve image quality. The technique includes gathering images, segmenting and pre-processing them, then analyzing and categorizing the paddy illness. The K-means clustering approach is utilized to segment images, and characteristics are generated from the cluster impacted by the disease. Extracted are characteristics including contrast, homogeneity, correlation, energy, mean, variance, and standard deviation. To classify the disease, the extracted features from disease cluster have been given as classifier inputs.

Keywords**:** Contrast, Homogeneity, Correlation, Energy, Variance, Mean, Standard Deviation, Leaf Disease, Neural networks, conventional neural networks

1. Introduction

Getting additional value-added products is essentially dependent on a functioning product quality control system. Numerous studies demonstrate that a variety of factors can lower the quality of agricultural products. Plant diseases are among the most significant contributors to this kind of quality. As a result, reducing plant diseases enables significantly raising product quality. One of the most extensively used food plants, rice is also known by its particular name, Oryza Sativa, and it was first cultivated in Asia. More over half of the world's population depends on rice as a food source, making it important crop globally. A basic diet for several people worldwide, including Malaysians, is rice. Nonetheless, a number of reasons contribute to the slowdown and decreased productivity of paddy rice production. The paddy illness is one of the primary causes. A disease is an aberrant state that harms a plant or causes it to perform improperly. Symptoms are a simple way to identify diseases. There are numerous varieties of paddy diseases, including brown spot disease, red disease virus, and Bakanae. Technologies like computer vision and image processing are particularly helpful to the agriculture sector. They have greater promise and significance for a variety of agricultural technology fields. One of the most helpful systems is the Paddy Disease Detection System. It can aid in the paddy farmer's quicker illness detection. The aim of this project is to create a prototype system that uses image processing techniques in addition to or instead of the manual method to automatically identify and categorize paddy diseases. India is a rapidly developing nation, and its early development was mostly dependent on agriculture. The principles of globalization and industrialization are posing challenges to the field. Furthermore, the younger generation needs to be made aware of the importance of cultivation and its necessity. Although technology is essential in every area these days, agriculture still employs some antiquated practices. Erroneous plant disease identification results in significant losses in terms of production, time, cost, and product quality. Determining the state of the plant is crucial to its proper cultivation. Identification used to be done manually by skilled individuals, but with so many environmental changes, prediction is getting harder. Thus, we may identify plant diseases using image processing techniques.

Since disease signs are typically visible on leaves, stems, blossoms, etc., we use leaves in this instance to identify the plants that are afflicted with the illness. Features in HSV, RGB, YIQ, and dithered images are extracted. In proposed system, feature extraction from RGB images is incorporated. A novel automatic technique for segmenting disease symptoms in digital photos of plant leaves. Various plant species' illnesses have been mentioned. A small number of the illness names in this system have been classified. This work performs the disease recognition for leaf image.Since India is renowned for its agricultural output, the majority of its citizens work in the sector. An important part of the economy is played by the agriculture sector.

For a significant portion of the population, land farming offers a variety of jobs and career options [1], [2]. For those who work in agriculture to make more money, the health of the plants is a major consideration. This can be accomplished by regularly monitoring the health of the plants, which is necessary at different phases of their growth in order to prevent numerous diseases that might harm the plants as they develop. The presence of pests and illnesses can significantly reduce crop yields and have an impact on crop cultivation evaluation [3], [4]. These days, the system relies on visual inspection, which is thought to be a laborious procedure. Therefore, the demand for automatic plant disease detection that can be used to pinpoint the disease's maximum early on has arisen [5]. In an effort to remove plant diseases, farmers implement a vast array of disease tracking measures at regular periods [6]. By combining the benefits of an IOT agricultural land monitoring system with a few machine learning algorithms, an automated disease identification and prevention system has been introduced [7], [8], and [9]. In order to detect the presence of plant diseases and prevent them with the automatic medicine spraying process, we can also use a variety of IOT sensing devices, such as thermal reading sensors, moisture sensors, and color sensors that depend on differences in the plant's leaves [10]. These sensors' values are dependent on temperature, humidity, and color parameters.

The majority of the microorganisms that cause damage to plants' leaves are bacteria, fungi, and viruses. Farmers who grow plants affected by various illnesses may be able to observe these indications with their unaided eyes. When these organisms cause diseases in plants, the symptoms can include recognizable changes in the plant's color, typical shape, or ability to perform essential functions like photosynthesis. As a result, we can go into greater detail on those plant symptoms [11], [12].

Proposed model

The suggested method's entire workflow, which begins with picture acquisition—that is, gathering the photographs from the database—is shown in Fig 1. The Kmeans clustering technique is used to segment these images, and then features are taken out of the clusters and fed as input to the ANN classifier. Gathering images from a database is called image acquisition. Plant Village Data Base is where the photos are loaded from. Tomato leaf spot, cotton leaf spot, and tomato leaf health are loaded images. picture segmentation, which uses the k-means clustering method, is the procedure of splitting a picture into various portions, or clusters.

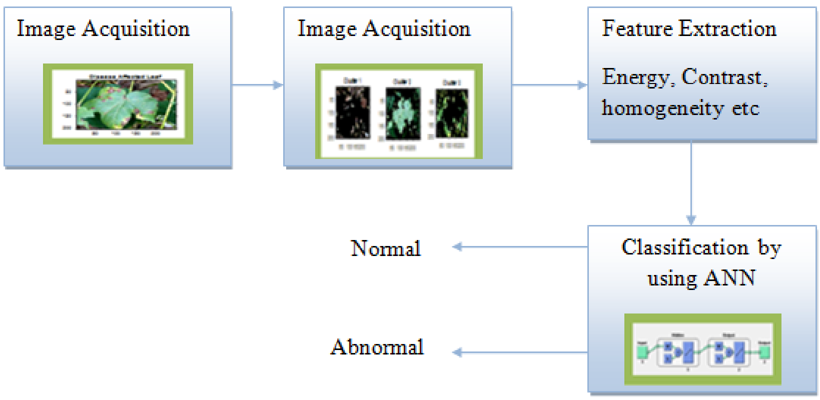

Fig. 1. Suggested technique for Disease Detection

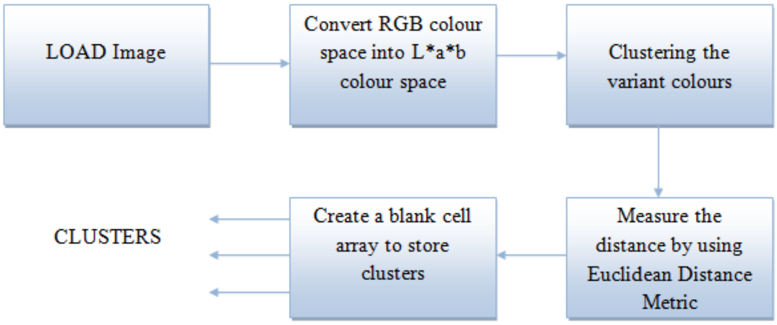

Fig. 2. K-Means clustering method

As seen in figure 2, the stained portion and healthy leaf region are separated using the K-means clustering method. The first step in this is to load the image from database into MATLAB and then convert RGB image to the L*a*b* color space. L* stands for lightness, and a*, b*, and c* for the layers of chromaticity. The a* and b* layers include all of the color information. The next action is to group the different colors together. By reallocating each pixel to the closest clusters, the image is divided into three parts, reducing the total distance and recalculating the cluster centroids. Every cluster is made up of various leaf image parts. Using the findings from the K means, each pixel in image is labeled using the index values of three clusters. The next action is to make a blank cell array to hold the clustering results.

K-Means Clustering

One of the traditional, well researched unsupervised learning techniques that resolves the basic clustering problem is k-means clustering [2]. It makes an effort to identify potential categories in the provided data by grouping objects into clusters whose constituents share a common characteristic. Hence, an item collection that is "similar" to one another and "dissimilar" to the objects in other clusters is referred to as a cluster. One of the most significant unsupervised learning strategies is k-means clustering. Further information regarding the k-means clustering is given in Section 2. The following are potential benefits of using the k-means clustering method: (1) addressing various attribute kinds; (2) identifying arbitrary-shaped clusters; (3) requiring minimal domain expertise to calculate input parameters; (4) handling noise and outliers; and (5) decreasing data dissimilarity. As a result, it has uses in a variety of industries, including biology, marketing, and image identification. But in order to use k-means clustering effectively, we must address some of its drawbacks:

(1) There is no specification on how to initialize means. A common method of beginning is to select k samples at random;

(2) the outcomes are dependent on the initial mean values, and it is common to find suboptimal partitions. Trying a variety of starting points is the typical approach;

(3) it occasionally occurs that the set of samples closest to a certain cluster center is empty, making updates impossible. An implementation must address this annoyance:

(4) the outcomes rely on metric utilized to calculate degree of dissimilarity among a particular sample andparticular cluster center. Normalizing each variable by its standard deviation is a common method, yet it's not always the best option;

(5) the outcomes depend on k value.

CLASSIFICATION

This paper uses a neural network method for classification. The neural network receives seven extracted features as input: contrast, correlation, energy, standard deviation, mean, homogeneity, and variance. The target data is provided as a class vector to the neural network. In this instance, the data was classified using a backpropagation neural network. After the network has finished training, it displays the error histogram plot, confusion matrix, and performance plot.

Neural networks (NN)

Deep learning's workhorses are neural networks. Furthermore, despite their seeming lack of transparency, these models are ultimately attempting to achieve the same goal as any other model: accurate prediction. I apologize for the awful puns. We employ NNs, which are multi-layer networks of neurons (seen in figure below as the blue and magenta nodes), to classify objects, forecast the future, and other tasks.

PROPOSED TECHNIQUE

Convolutional neural networks (CNN). It may sound like a strange mash-up of math and biology with a dash of computer science, but these networks are among the most important developments in computer vision. Neural nets gained popularity for the first time in 2012 when Alex Krizhevsky utilized them to win the ImageNet competition, which is akin to the yearly Olympics of computer vision. At the time, this achievement was remarkable since it reduced the classification error record from 26% to 15%. Since then, deep learning has been the foundation of many businesses' offerings. Facebook's automatic tagging algorithms, Pinterest's personalized home feed, Google's photo search, Amazon's product suggestions, and Instagram's search architecture all make use of neural nets.

A. Convolutions Over Volume

Assume we have 3-D input image of the dimensions 6 X 6 X 3 in place of a 2-D image. How will convolution be applied to this picture? Rather than using a 3 X 3, we will utilize a 3 X 3 X 3. Let us examine an instance:

- **Input:** 6 X 6 X 3
- **Filter:** 3 X 3 X 3

The width, height, and channels in filter and input are represented by the dimensions above. Remember that the filter and input should have same number of channels. The output that comes from this is 4 X 4. Let's see it graphically:

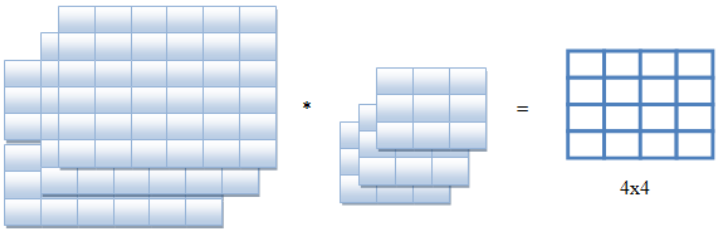

Figure.3. CNN Model

The filter will have three channels as a result of the input having three channels. Figure 3 illustrates the 4 X 4 matrix that is the output shape following convolution. Consequently, the initial element of output is the total of element-wise product of the 27 values from filter and the first 27 values from input, or 9 values from every channel. We then convolve across the whole image after that. We have the option to employ many filters in place of simply one. How are we going to do that? As seen in figure 4, let's assume that the first filter will identify the image's vertical edges and 2nd filter will identify its horizontal edges. Using more than one filter will alter the output dimension. Therefore, as opposed to the 4 X 4 result shown in the example above.

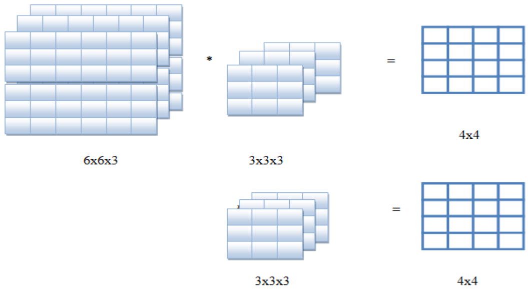

Figure.4. Output image dimensions

Would have a 4 X 4 X 2 output (if we have utilized 2 filters):

Generalized dimensions might be provided as:

- **Input:** n X n X n_c
- **Filter:** f X f X n_c
- **Padding:** p
- **Stride:** s
- **Output:** [(n+2p-f)/s+1] X [(n+2p-f)/s+1] X n_c’

Here, n_c’ is the no. of filters and n_c is the no. of channels in filterand input

INTERNET OF THINGS (IoT)

The IoT is a sophisticated automation and analytics system, which utilizes big data, networking, artificial intelligence, sensing, and sensing methods to supply entire systems for a good or service. When used in any system or industry, these systems enable increased performance, control, and transparency.

IoT systems' exceptional versatility and adaptability to any setting make them useful in a variety of industries. With use of smart devices and potent enabling technologies, they improve operations, automation, data collection, and much more.

IoT

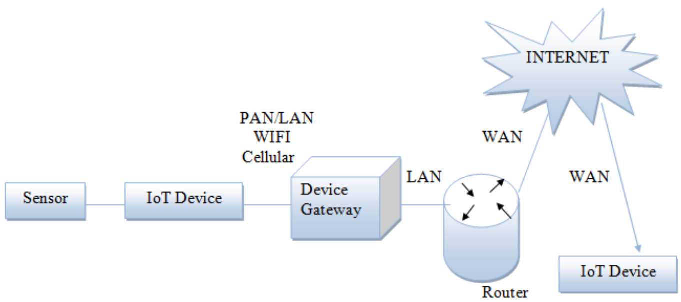

Figure.5. IOT structure

In order to serve the growing IoT market, wireless cellular companies are aiming to improve and provide collectivity for their current wireless devices. The structure of the IoT is shown in figure 5 with sensors and routers collaborated with the device gateway.

IOT DEVICE AND COMPONENTS

The primary power source for an Internet of Things device is a battery. It ought should last for a good ten years or more. The components include of sensor interface and wired and wireless network communication. As a result, it interfaces with application layer through a tiny portion of physical layer as well as higher protocol layers. IP protocols based on both IPV4 and IPV6 should be supported by devices. The receiver sensitivity of IoT devices should be at least 20dB greater than that of non-IoT devices. The cost of IoT devices ought to be less than $10. See IoT components for additional details.

Results & Analysis

Figure 6 illustrates that while there are numerous conventional techniques for recognizing plant leaf disease, the primary means of reducing agricultural losses is the identification and treatment of plant disease. This survey highlights the salient characteristics and contemporary significance of plant disease detection, identification, and prevention. The Support Vector Machine algorithm is employed in our suggested approach to efficiently classify the features. Additionally, the convolution neural network model was utilized in this work to test, train, and validate the user's input into the system. Using this method, we were able to identify the diseased or infected plant leaf parts and provide the appropriate treatment to cure them, as illustrated in Figure 7. Few village datasets that are accessible for our project work and are utilized to train and test the NN model are listed below. By utilizing additional local features in addition to the global features and training the system with many photos, the accuracy of the system can be improved. Here, we have tested the accuracy of this model across a total of 10 epochs, during which 20% of the photos from the village's plant dataset were used.

Figure.6. Detected Disease GUI a) Query Image b) Contrast enhanced c) Segmented ROI

(a)

Figure.7. Segmented by K Means a)Original Image b) Cluster 1 c) Cluster 2 d) Cluster 3

The testing dataset yields an accuracy of more than 98.82%, meaning that out of 100 photographs input, 95 images were correctly identified, as illustrated in figure 8. The accuracy increases when training dataset and epochs are increased, and at sixth epoch, the proposed network method produces the best accuracy.

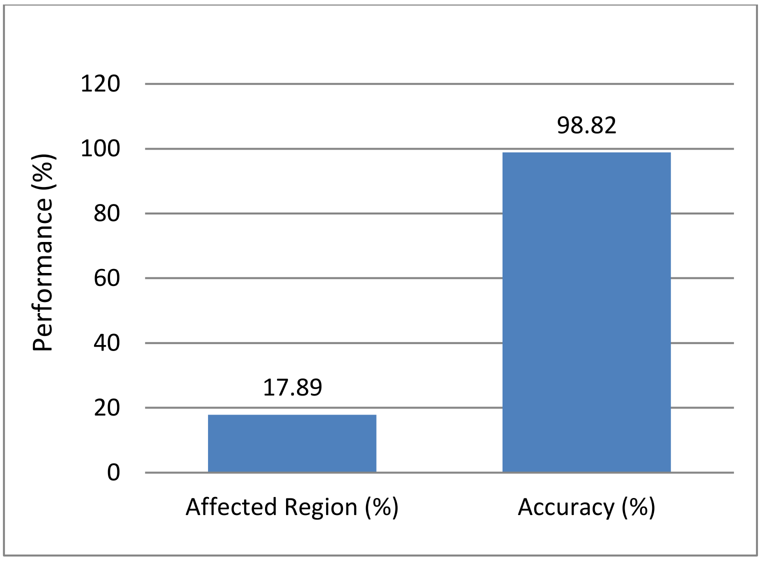

Figure.8. Performance levels of affected region and Accuracy

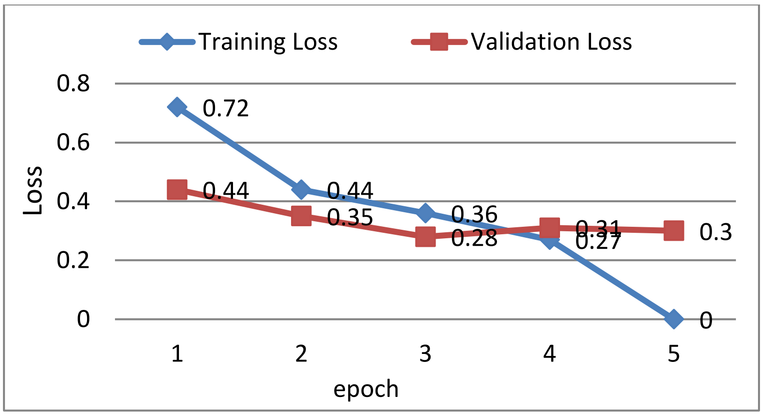

Figure.9. Training loss Vs Validation loss

The model's generated training and validation graphs' accuracy and loss are displayed as shown the figure 9 and 10. Every disease has unique side effects that come from the plant's leaves, stem, and root. This technique might assist farmers in quickly and accurately identifying and treating leaf infections through a logical and accurate path.

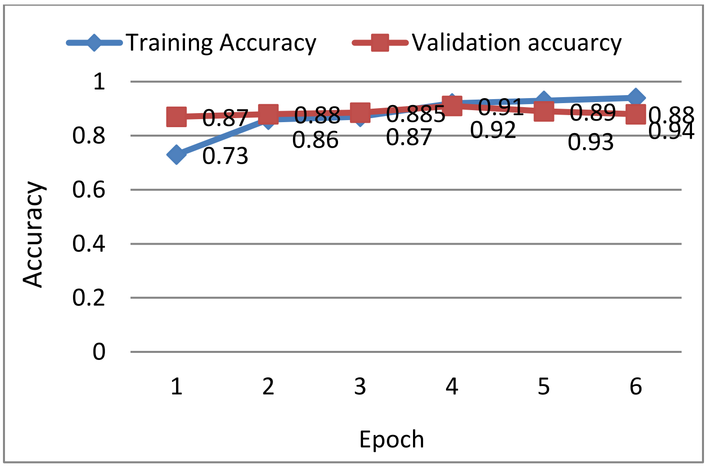

Figure.10. Training accuracy Vs Validation accuarcy

Training and validation Accuracy: The webpage below has a "browse image" option that allows you to upload an image from the Village datasets that are available. It is the GUI for detecting leaf diseases using OpenCV.

Conclusion

This initiative employs a novel concept to pinpoint the impacted crops and offer corrective actions to the farming sector. The leaf's diseased area is divided and examined utilizing k-mean clustering method. The pictures are supplied to our program so that illnesses can be identified. It offers a viable option for the agricultural population, especially in isolated villages. In terms of shortening the duration of clustering and the size of the affected area, it functions as an effective system. The feature extraction technique aids in both the classification of plant diseases and the extraction of the afflicted leaf. Excellent results are obtained from this approach for accuracy improvement when CNN and IOT are inserted. The suggested method is a useful one that can greatly aid in precise identification of leaf diseases with minimum computing work.

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